

# CMS **SILICON STRIP** TRACKER PROJECT

## Detector Construction

**Sensors** are purchased by CERN. They are delivered at CERN and shipped for Quality Test to Pisa, Perugia, Vienna and Karlsruhe. From here they are shipped to the Assembly Centres. Irradiation centres are Louvain and Karlsruhe. Process qualification and stability centres are Strasbourg and Vienna.

The testing and qualification process is under the responsibility of a Production Committee. For details see the [document](#) “ Specifications for the quality control and assurance of the CMS Silicon Sensors”

**Frames** are produced under the responsibility of Brussels(\*) and shipped to the Assembly Centres.

**FE Hybrids** are produced, populated and tested under the responsibility of Strasbourg and shipped to CERN.

**Pitch** adapters are produced and tested under the responsibility of Brussels and shipped to CERN.

CERN(\*) glues and bonds pitch adapters to the hybrids, test them and ship them to the Assembly Centres.

The **Assembly Centres** are: Brussels, Lyon, Perugia, Bari/**Catania**, 2 x Fermilab<sup>1</sup>. They will assemble the detectors, perform mechanical and simple electrical acceptance tests and ship them to the bonding centres. There is a working group to ensure the uniformity of the procedure. A document on specifications for the quality control and assurance is in preparation. *under the responsibility of G. Fiore.*

Fermilab will produce all TOB detectors (~34% of the total ) , Bari/**Catania** and Perugia will produce all TIB detectors and 25% of the thin wedge detectors ( ~23 % of the total), Brussels and Lyon will produce all the thick wedge detectors and 55% of the thin wedge detectors (~37% of the total).

The **Bonding Centres** are: 2xFermilab, Firenze, Bari/**Catania**, Torino, Padova, Pisa, Karlsruhe, Aachen, Strasbourg, Zurich. They will bond the detectors, perform *simple* tests after bonding and ship the modules to the “burn in” centres. There is a working group to ensure the uniformity of the procedure. A document on specifications for the quality control and assurance is in preparation. *under the responsibility of A. Honma.*

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\* (\*) these item has to be evaluated to verify the availability of local resources before taking the full responsibility for delivery

<sup>1</sup> The following USA institutions collaborate with Fermilab in the SST project: Kansas, Purdue, Rochester and Northwestern

Fermilab will bond the detectors assembled there. INFN<sup>2</sup> groups will bond the detectors assembled in Perugia and Bari. CE<sup>3</sup> groups will bond the detectors assembled in Brussels and Lyon.

Vienna will assemble and bond 20% of the thin wedge detectors (~ 4% of the total) with a non robotic method. They will coordinate their procedure with the other centers.

## Mechanical Structures and burn in of modules

**TIB** and **TID** mechanical structures and the related tools are produced by INFN. A fraction of the TIB shells may be assembled, measured and tested at Fermilab using the fixtures and the carbon fiber parts procured by INFN. The shells assembled in Fermilab are sent back to Pisa. Services and electronics are mounted on shells and disks. **Bari is responsible for the design and the procurement of the cables in the cold volume.** Modules mounted on the shells and on the disks and then are burnt-in in INFN laboratories. The TIB and TID are mounted, tested and then shipped to CERN.

**TOB** mechanical structure, rods and the related tools are produced under the responsibility of Finland and CERN. The Outer barrel parts are shipped to CERN and mounted in the support tube. The services are mounted on the structure. Rods arrive at CERN already equipped with cooling pipes. They are equipped at CERN with remaining services and electronics, and tested. Rods are then shipped to Fermilab where the modules are mounted and burnt-in on the rods. Rods are shipped to CERN, tested and mounted in the outer barrel.

**TFE** structures are produced by Aachen, the tools by Karlsruhe, Lyon is responsible for the design of the services from the disks to the end-flange. One Endcap is pre-assembled by Aachen and Brussels, the other Endcap by Karlsruhe and Strasbourg. Petals - already equipped with services and electronics- are produced by Aachen in collaboration with other institutes of the CE, Louvain is responsible for the cooling on the petals. Modules are assembled into petals and burned-in in: Aachen, Karlsruhe, Strabsourg/Mulhouse, Lyon, Brussels/Antwerp and Louvain (about 50 petals each). The petals are shipped to Aachen and Lyon. The petals are inserted and tested in one Endcap in Aachen and in the other Endcap in Lyon. **After full commissioning** the Endcaps are shipped to CERN.

There is a working group to ensure the uniformity of the burn-in procedures. A document on specifications for the quality control and assurance is in preparation. *under the responsibility of M. Meschini.*

The **support tube**, the **thermal screen**, the **end-flanges**, the **tools for the installation of the Tracker** as a whole and into CMS, the **beam pipe supports** are built by CERN. CERN is also responsible for the overall mechanical integration and for the transport and installation of the Tracker into CMS.

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<sup>2</sup> The INFN consortium includes Bari, Catania, Firenze, Padova, Perugia, Pisa and Torino

<sup>3</sup> The CE consortium includes Austria: Vienna; Belgium: Brussels UVB, Brussels ULB, Antwerpen, Louvain-La-Neuve, Mons; Germany: Aachen I, Aachen III, Karlsruhe; France: Mulhouse, Lyon, Strasbourg; Switzerland: ETH Zurich

The **Position Monitoring system** will be designed and built by Aachen and CERN. It will be integrated in the various structures during their installation and commissioning.

## Power, Cooling and Services

Florence and Torino are responsible for the **Power Supplies system**. The system will be designed in Florence. Power supplies will be tested in Florence and Torino. A fraction of the power supplies will be delivered to the burn-in centers, **to the sub-assembly centers** and later to CERN. The remaining directly to CERN.

Florence and Torino are responsible for the design and specification of the **cables outside the cold volume**. *from the subdetectors to the patch panels and to the counting room*. CERN is responsible for **the patch panels** and for the procurement of the cables.

Installation of **cables** and **cooling pipes** between detector and service cavern / racks at exp. cavern hall will be done with industry under the supervision of CERN

CERN is responsible for the **cooling plants** and for the **inert gas system**.

CERN is responsible for the **slow control** system that controls temperature, cooling and power. A team of about 4 people has to work on it for 3 years. CERN will provide 50% of this manpower, the remaining manpower has to be provided by the other institutes of the collaboration. A description of the related software will be produced before the end of year 2000 with the assignment of the responsibility for the different modules.

## Electronics

**APV25** and **MUX** are designed by UK, **PLL** is designed by CERN, **DCU** is designed by Pisa and CERN. The wafers are procured by UK and CERN and tested by UK. Diced ASICs are then shipped to Strasbourg. Padova will take significant responsibilities on the quality insurance for the tolerance to radiation effects on the basis of sample wafer testing. A document on specifications for the quality control and assurance is in preparation. *under the responsibility of G. Hall*.

**Laser drivers** and **lasers** with pig-tail and connectors are procured and tested by CERN and shipped to Perugia. **A document on specifications for the quality control and assurance is in preparation**

**Analogue Opto-Hybrids** are designed procured, populated and tested under the responsibility of Perugia\* and shipped to the centers that install the modules on the mechanical structures. . . **A document on specifications for the quality control and assurance is in preparation**

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**Digital Opto-Hybrids** and their components (**RX40, LD, pin diodes, laser diodes**) are designed, procured, populated and tested by CERN and shipped to the centers that install the modules on the mechanical structures.

The entire embedded **slow control system (CCU, CCUM, etc...)** are designed, procured, populated and tested by CERN and shipped to the centers that install the modules on the mechanical structures.

The **optical fibres**, their **connectors** and the **patch panel** are procured and tested by CERN.

The **FED** is designed by UK, its analogue receiver is designed by CERN. The FED are procured and tested under the responsibility of UK. *A fraction of the FED's will be delivered to the burn-in centers and then to CERN. The remaining directly to CERN.*

The **FEC** is designed by CERN, its digital transceiver is designed by Vienna. The FEC are procured and tested under the responsibility of CERN and Vienna. *A fraction of the FEC's will be delivered to the burn-in centers and then to CERN. The remaining directly to CERN.*

## **Integration of the Electronics chain and data acquisition**

The integration of the electronics chain is done under the responsibility of CERN by a team of about 20 people that will work for 5 years. CERN will provide up to 8 FTE for this activity and the rest is has to be provided by the other institutes of the collaboration. This activity includes the development of the control of the electronics chain, the development of the calibration procedure and the data acquisition. In this framework is included also the support for the Test Beam activity. A description of the related software will be produced before the end of year 2000 with the assignment of the responsibility for the different modules.

## **Detector and electronics production flow and traceability**

A package for the monitoring of production components and for storage of test results is being developed under the coordination of Lyon. It is expected that all institutions provide the manpower for its development and for the support during the construction. A description of the related software will be produced soon with the assignment of the responsibility for the different modules.

## **Reconstruction software and alignment**

It is expected that all institution will provide manpower for the development of the simulation and reconstruction software related to the Tracker, including a detailed description of the Tracker in the MonteCarlo. This activity includes also the development of the software for the alignment of the Tracker with particles and for the on-line monitoring of the Tracker. A description of the related software will be produced before the end of year 2000 with the assignment of the responsibility for the different modules.

## Money matrix

The sharing of the financial responsibility is summarised in the appended money matrix. The total core budget match the ceiling of 69.3 MCHF for the Silicon Strip Tracker including 10% contingency on the construction (this assumes that the pixel budget is 8.2 MCHF including 10% contingency).

The entry of 2M\$ (Cost Book deliverables) from the US into the Tracker is under request. The aim is to put this request as the highest priority in the release of the next tranche of US contingency, possibly in Apr 01. Including this 2M\$ the funding of the Tracker is only 65.2 MCHF. To match the cost with the funding we propose to stage 4 MCHF that correspond to 50% of the counting room electronics<sup>4</sup>. The funding of this remaining part will be a responsibility of the whole CMS community. It is also possible that we will be in a position to cover part of these 4 millions from the contingency. It is important to recall that to prepare this budget that includes 10% contingency we have been obliged to remove the second coordinate layer from layer 4 of TOB (i.e. there are now only two double layers in TOB).

The list of items in the second column of the table contains construction elements (PBS entries) and also actions (WBS entries). The latter have no budget since we assume that we can do them with manpower and infrastructures that we have in our institutes. This is a big added value, to give the measure of it USA – where they budget in a different way - have an extra contribution of 2.3 M\$ (in addition to the 2 M\$ you find in the table) for building the TOB modules and commissioning the rods.

The last two items (Test stands and Manpower) are special. They do not belong to the construction budget but are included in the core. They do not have the 10% contingency because they are a sort of contingency for infrastructures and labour that we may not have in our institutions. For this reason their share is difficult. We also propose that we make all our effort to limit the use of this money to the bare minimum so that we can use this contingency to procure the electronics that we miss.

The table does not contain a time profile of the expenditure. We will iterate on this point, but it is clear that we will need flexibility. In general we should look at the budget of the Tracker as a common responsibility. If we will have a problem somewhere, this will be a common problem. If one item turns out to be less expensive than what is foreseen, we can use the money to solve a common problem elsewhere. **The Tracker Budget will be revised by the FB every year in the month of June to take into account the progresses in the definition of the cost of each item. Following this update the money matrix will be revised by the FB that will make a proposal for possible changes to the TIB. To date only a minimal part of the expenditure is defined by contracts. We expect that the revision in June 2001 will clarify the cost of about 50% of the budget.**

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<sup>4</sup> To be precise we should stage 4.177 MCHF. I have rounded to 4 MCHF and I have put the 0.177 as deficit in the CERN contribution.

